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## Description

This invention relates to treating matter, for example particulate and/or liquid matter.

Our specification EP-B-68853 discloses apparatus for treating matter having a treating region defined by a structure including a base provided with an annular fluid inlet means, means for supplying matter to the region and for extracting treated matter means for supplying fluid to the annular inlet fluid means and means for imparting vertical and circumferential components to the flow of fluid through the inlet means for moving a bed of said matter in said region in a band along an annular path in said region as said fluid passes through said bed.

We have now devised a development of the apparatus disclosed in the above-mentioned European patent specification which is advantageous in certain applications in that it increases the capacity of apparatus of a given overall size and/or provides for more efficient treatment of particular classes of matter.

The invention includes apparatus for treating matter, comprising at least two treating regions, each region being defined by a structure including a base provided with an annular fluid inlet means, said annular inlet means of the regions being disposed concentrically about an upwardly directed axis of the apparatus; means for supplying matter to be treated to the region provided with the radially outer of the annular inlet means; means for enabling matter to be extracted from the region provided with the radially inner of the annular inlet means, means for transferring matter from a said region whose annular inlet means is disposed radially outwardly of that of another region to said other region; means for supplying fluid to each annular fluid inlet means; and means for imparting vertical and circumferential components to the flow of fluid through each inlet means for moving respective beds of said matter in said regions in respective bands along respective axially and radially spaced concentric annular paths in said regions as said fluid passes through said beds.

The annular inlet means of said regions may be spaced axially, the axially upper of said annular inlet means being disposed radially outwardly of the other annular inlet means.

Preferably, when the apparatus comprises more than two said regions, the annular inlet means of each region other than the region provided with the axially upper inlet means is disposed radially inwardly of the inlet means next above it.

The invention also includes a method of treating matter in at least two treating regions each of which is bounded by a base wherein in each region

a bed of matter is moved in a band continuously along an annular path above the fluid inlet means thereof by passing fluid supplied to the region through said annular fluid inlet means through the bed along said path, the annular paths of the regions being concentric and radially spaced, and wherein the matter to be treated is supplied to the region having the radially outer of said paths and extracted from the region having the radially inner of said paths, the matter being transferred from the or each region whose annular path is disposed radially outwardly of that of another region to said other region.

The concentric annular paths may be spaced axially the axially upper of the annular paths being disposed radially outwardly of the other annular path or paths. Furthermore, preferably in such a method when the matter is passed through more than two regions, each annular path other than the axially upper path is disposed radially inwardly of the annular path next above it.

The fluid which is passed through the beds may comprise gaseous matter which treats, or reacts with, the matter in said beds.

This gaseous matter may comprise combustion gases which heat the matter in said beds during passage through said beds.

Additionally or alternatively the fluid which is passed through said beds may comprise liquid matter which treats, mixes with, or reacts with the matter in said beds during passage through said beds. Additionally or alternatively the fluid which is passed through said beds may comprise air.

The matter which is treated in the treating regions may comprise particulate matter and/or liquid matter.

In order that the invention may be well understood, an embodiment thereof will now be described, by way of example only, with reference to the accompanying schematic drawing, in which:

Figure 1 is a top plan view of an apparatus for treating matter; and

Figure 2 is an aerial cross-section of the same apparatus taken along the line II-II in Figure 1.

The apparatus 10 shown in the drawing comprises two treating regions 12 and 14 through which matter to be treated sequentially passes. Each region 12, 14 is bounded externally by a respective tubular wall 16, 18 and in the illustrated apparatus, both regions 12 and 14 are annular, being bounded internally by respective tubular walls 20, 22. Each region 12, 14 has a base 24, 26 provided with an annular fluid inlet 28, 30 which is spanned by an annular array of inclined vanes 32, 34. For simplicity, only a portion of the arrays of vanes is illustrated in Figure 1. However, it is to be understood that each array extends completely around the respective inlets 28, 30. The vanes which

in the embodiment are fixed and arranged in overlapping relationship are inclined in order to impart vertical and circumferential components to the flow of fluid through the inlets 28, 30 for moving respective beds of the matter in the regions 12 and 14 in respective compact bands continuously along respective annular paths in the regions as indicated by arrows 36 and 38 in Figure 1 as the fluid passes through the matter in the beds. The bands are indicated at 29 and 31 respectively in Figure 2.

The annular inlets 28 and 30, and thus the annular paths in the regions 12, 14 along which the beds of matter is moved, are disposed concentrically about an upwardly directed axis 40 of the apparatus.

In the illustrated embodiments, the annular inlets and the annular paths associated therewith are spaced both axially and radially; with the upper of the annular inlets (and the annular path associated therewith) disposed radially outwardly of the other annular inlet (and the annular path associated therewith). This arrangement is particularly advantageous in that it enables the internal tubular wall 20 of region 12 to be formed as a continuation of the external tubular wall 18 of the region 14.

The fluid which is passed through the beds of matter to move the beds continuously along the annular paths in the regions 12 and 14 is directed to the annular inlets 28 and 30 through respective supply passages 42, 44 beneath the inlets as indicated by arrows 46, 48 in Figure 2.

The illustrated apparatus is provided with an inlet 49 at its upper end to enable matter to be treated to be supplied to the region 12 as illustrated by arrows 50 in Figure 2. The internal tubular walls 20 and 22 of the regions 12 and 14 are provided with respective openings 52, 54. The opening 52 enables matter to be transferred from region 12 to region 14 as indicated by arrow 56 in Figure 2, and the opening 54 enables matter to be extracted from the region 14 as indicated by arrow 58 in Figure 2. The matter extracted from region 14 exists the apparatus via outlet 60.

In use, matter is supplied to the region 12 to form a bed therein which is moved in band 29 continuously along an annular path by passing fluid through the bed along that path and is treated in region 12. The cross-sectional size of the band 29 of matter being moved in region 12 depends upon the amount of matter in that region. Initially, when matter is first supplied to the region 12, the band has a small cross-section and moves adjacent the external wall 16. On introduction of further matter, the cross-section of the band increases both radially inwardly and axially upwardly such that when the matter in region 12 exceeds a predetermined amount, excess matter will exit the region 12 through opening 52, to be transferred to region 14

to form a bed therein which is moved in a band continuously along an annular path by the fluid which is passed through the bed along that path, and be treated in region 14. As with the band 29, the cross-sectional size of the band 31 of matter being moved in the region 14 depends on the amount of matter in that region. Likewise, initially when matter is first transferred to the region 14 from region 12, has a small cross-section and moves adjacent the external wall 18 of region 14. On transfer of further matter, the cross-section of the band 31 increases both radially inwardly and axially upwardly such that when the amount of matter in region 14 exceeds a predetermined amount, excess matter exits from region 14 through opening 54.

Thus, it will be appreciated that once the two regions 12 and 14 contain the above-mentioned predetermined amounts of matter, supply of further matter to region 12 results in matter being transferred from region 12 to region 14 and matter being extracted from region 14. In this way a throughput of matter is achieved, the matter passing sequentially through the two regions 12 and 14 before exiting the apparatus.

The above described apparatus and method are particularly advantageous for treating matter which after being treated does not automatically rise from the bed to exit from the apparatus (as is the case for example when perlite is expanded by being heated by combustion gases which are passed through the bed as described in our specification EP-B-68853). Although there is no control in how long particular matter is retained in region 12 before being transferred to region 14 nor how long particular matter is retained in region 14 before exiting the apparatus, the fact that the matter being treated is passed through two regions enables an average treatment time to be achieved. If the treatment time is particularly critical, more control over the treatment time may be achieved by modifying the apparatus to include a further region or regions like regions 12 and 14 having annular paths concentric with the annular paths provided by regions 12 and 14. Thus, for example the illustrated apparatus could be modified to have a further region provided with an annular inlet spaced axially below and radially inwardly of inlet 30 of chamber 14. In this case, it will be appreciated that matter would be transferred from region 14 to this further region and eventually exit the apparatus from the further region.

The matter which is passed through the treating regions may comprise particulate matter and/or liquid matter. The fluid which is passed through the beds may comprise gaseous matter which treats, or reacts with the matter in the beds. For example, the gaseous matter may comprise combustion gas-

es which heat the matter in the beds during passage through the beds. One particular example, is the case where the matter being treated comprises coffee beans which are roasted as they pass through the regions by combustion gases. Another example is where the matter to be treated comprises a slurry from which the liquid is driven off by the combustion gases.

The fluid which is passed through the beds may comprise liquid matter which treats, mixes with, or reacts with the matter in the beds during passage through the beds. Again in this case, the matter in the beds may comprise particulate matter and/or liquid matter. For example, the liquid which is passed through the beds may chemically react with matter in the beds comprising solid particulate matter suspended or dissolved in liquid matter.

The fluid which is passed through the beds may alternatively comprise air in which case the purpose of the fluid may be merely to move the matter in the beds along their annular paths. For example, the matter in the beds may comprise particulate matter and liquid matter which coats the particulate matter as both the particulate matter and liquid matter are moved along the annular paths.

It will also be appreciated that a different fluid may be passed through each bed to enable different treatments to be carried out on the matter when it is in each bed.

It will be appreciated from the above that by providing a plurality of treating regions through which the matter to be treated passes sequentially and in which the matter is moved along respective concentric annular paths, the path length for the matter (and thus the capacity of the apparatus) is increased for a given overall size as compared with the apparatus disclosed in our specification EP-B-68853 where only one treating region having an annular path is present.

Whilst the embodiment discloses one particular arrangement of concentric paths in which two annular paths are spaced both axially and radially with the axially upper of the annular paths disposed radially outwardly of a lower annular path, it is to be understood that more than two annular paths may be provided and that these paths may be spaced only radially.

## Claims

1. Apparatus for treating matter, comprising at least two treating regions (12,14), each region being defined by a structure including a base (24,26) provided with an annular fluid inlet means (28,30), said annular inlet means of the regions being spaced radially and disposed concentrically about an upwardly directed axis

(40) of the apparatus; means (49) for supplying matter to be treated to the region provided with the radially outer of the annular inlet means; means (54,60) for enabling matter to be extracted from the region provided with the radially inner of the annular inlet means, means (52) for transferring matter from a said region whose annular inlet means is disposed radially outwardly of that of another region to said other region; means (42,44) for supplying fluid to each annular fluid inlet means; and means (32,34) for imparting vertical and circumferential components to the flow of fluid through each inlet means for moving respective beds of said matter in said regions in respective bands along respective axially and radially spaced concentric annular paths in said regions as said fluid passes through said beds.

2. Apparatus as claimed in claim 1, wherein said annular inlet means of said at least two treating regions are spaced axially, the axially upper (28) of said annular inlet means being disposed radially outwardly of the other annular inlet means (30).
3. Apparatus as claimed in claim 2 and comprising more than two said regions, wherein the annular inlet means of each region other than the region provided with the axially upper inlet means is disposed radially inwardly of the inlet means next above it.
4. A method of treating matter in at least two treating regions (12,14) each of which is bounded by a base (24,26) wherein in each region a bed of matter is moved in a band (29,31) continuously along an annular path above the fluid inlet means (28,30) thereof by passing fluid supplied to the region (12,14) through said annular fluid inlet means (28,30) through the bed along said path, the annular paths of the regions being concentric and radially spaced, and wherein the matter to be treated is supplied to the region (12) having the radially outer of said paths and extracted from the region (14) having the radially inner of said paths, the matter being transferred from the or each region whose annular path is disposed radially outwardly of that of another region to said other region.
5. A method as claimed in claim 4, wherein the annular paths of the regions (12,14) are spaced axially, the axially upper of said annular paths being disposed radially outwardly of the other annular path or paths.

6. A method as claimed in claim 5, wherein the matter is passed through more than two regions and wherein each annular path other than the axially upper path is disposed radially inwardly of the annular path next above it. 5
7. A method as claimed in any one of claims 4 to 6, wherein said fluid which is passed through said beds comprises gaseous matter which treats, or reacts with, the matter in said beds. 10
8. A method as claimed in claim 7, wherein the gaseous matter comprises combustion gases which heat the matter in said beds during passage through said beds. 15
9. A method as claimed in any one of claims 4 to 8, wherein said fluid which is passed through said beds comprises liquid matter which treats, mixes with, or reacts with the matter in said beds during passage through said beds. 20
10. A method as claimed in any one of claims 4 to 9, wherein said fluid which is passed through said beds comprises air. 25
11. A method as claimed in any one of claims 4 to 10, wherein said matter which is treated in said treating regions comprises particulate matter. 30
12. A method as claimed in any one of claims 4 to 11, wherein the matter which is treated in said treating regions comprises liquid matter.

#### Patentansprüche

1. Vorrichtung zur Behandlung von Substanzen, die aus wenigstens zwei Behandlungsbereichen (12,14) besteht und jeder Bereich durch einen Aufbau beschrieben wird, der eine Grundplatte (24,26) enthält, die mit einem ringförmigen Fluid-Einlaßmittel (28,30) versehen ist und die ringförmigen Einlaßmittel der Bereiche radial beabstandet und konzentrisch um eine aufwärts gerichtete Achse (40) der Vorrichtung angeordnet sind; Mittel (49) zum Zuführen von zu behandelnden Substanzen zu einem Bereich, der mit dem radialen Äußeren des ringförmigen Einlaßmittels verbunden ist; Mittel (54,60), die es erlauben, Substanzen aus dem Bereich zu entfernen, der mit dem radialen Inneren des ringförmigen Einlaßmittels verbunden ist, und Mittel (52) zum Transportieren der Substanzen aus dem Bereich, dessen kreisförmiges Einlaßmittel radial nach außen von einem weiteren Bereich zu diesem anderen Bereich angeordnet ist, sowie Mittel (42,44) zum Zuführen von Fluid an jedes ringförmige Fluid-

- Einlaßmittel und Mittel (32,34) zur Zerlegung der Fluidströmung in Vertikal- und Umfangskomponenten durch jedes Einlaßmittel zur Bewegung von entsprechenden Substanzschichten in den Bereichen in entsprechenden Streifen längs entsprechender axial und radial beabstandeter, konzentrischer, ringförmiger Wege in den Bereichen wo das Fluid durch die Schichten strömt.
2. Vorrichtung nach Anspruch 1, wobei die ringförmigen Einlaßmittel der wenigstens zwei Behandlungsbereiche axial voneinander beabstandet sind und das axial obere (28) der ringförmigen Einlaßmittel von dem anderen ringförmigen Einlaßmittel (30) radial nach außen angeordnet ist.
3. Vorrichtung nach Anspruch 2, die mehr als zwei Bereiche enthält, wobei das ringförmige Einlaßmittel jedes anderen Bereiches als dem mit dem axial oberen Einlaßmittel versehenen Bereich, radial einwärts von dem nächsten darüber liegenden Einlaßmittel angeordnet ist.
4. Eine Methode zur Behandlung von Substanzen in wenigstens zwei Behandlungsbereichen (12,14), von denen jeder durch eine Grundplatte (24,26) abgegrenzt ist, wobei in jedem Bereich eine Substanzschicht in einem Streifen (29,31) kontinuierlich längs eines ringförmigen Weges über dessen Fluid-Einlaßmittel (28,30) durch Strömen des in den Bereich (12,14) mittels ringförmigen Fluid-Einlaßmittels (28,30) zugeführten Fluids durch die Schicht längs des Weges bewegt wird und die ringförmigen Wege der Bereiche sind konzentrisch und radial voneinander beabstandet und wobei die Substanz, die bearbeitet werden soll, dem Bereich (12) zugeführt wird, der das radial Äußere der Wege darstellt und aus dem Bereich (14) entnommen wird, der das radial Innere der Wege darstellt, und die Substanz wird aus dem oder jedem Bereich transportiert, dessen ringförmiger Weg radial nach außen von dem eines weiteren Bereiches zu dem anderen Bereich angeordnet ist.
5. Eine Methode nach Anspruch 4, wobei die ringförmigen Wege der Bereiche (12,14) axial beabstandet sind und der axial obere der ringförmigen Wege radial nach außen von dem anderen ringförmigen Weg oder den Wegen angeordnet ist.
6. Eine Methode nach Anspruch 5, wobei die Substanz durch mehr als zwei Bereiche hindurchgeführt wird und wobei jeder ringförmige

Weg, anders als der axial obere Weg, radial einwärts zum nächsten darüber befindlichen ringförmigen Weg angeordnet ist.

7. Eine Methode nach einem der Ansprüche 4 bis 6, wobei das Fluid, das durch die Schichten hindurchgeführt wird eine gasförmige Substanz enthält, die die Substanz in den Schichten bearbeitet oder mit ihr reagiert.
8. Eine Methode nach Anspruch 7, wobei die gasförmige Substanz Verbrennungsgase enthält, die die Substanz in den Schichten während des Durchgangs durch die Schichten erhitzt.
9. Eine Methode nach einem der Ansprüche 4 bis 8, wobei das Fluid, das durch die Schichten hindurchgeführt wird, eine flüssige Substanz enthält, die die Substanz in den Schichten während des Durchgangs durch die Schichten bearbeitet, sich mit ihr mischt oder mit ihr reagiert.
10. Eine Methode nach einem der Ansprüche 4 bis 9, wobei das Fluid, das durch die Schichten geführt wird, Luft enthält.
11. Eine Methode, wie in einem der Ansprüche 4 bis 10, wobei die Substanz, die in den Behandlungsbereichen behandelt wird, eine Substanz aus Stoffpartikeln enthält.
12. Eine Methode nach einem der Ansprüche 4 bis 11, wobei die Substanz, die in den Behandlungsbereichen behandelt wird, eine Substanz aus Flüssigkeit enthält.

#### Revendications

1. Appareil de traitement de matière comprenant au moins deux régions de traitement (12, 14), chaque région étant définie par une structure comprenant une base (24, 26) dotée de moyens d'admission de fluide annulaires (28, 30), lesdits moyens d'admission annulaires des régions étant espacés radialement et disposés concentriquement autour d'un axe dirigé vers le haut (40) de l'appareil; des moyens (49) pour fournir de la matière à traiter à la région dotée de ceux des moyens d'admission annulaires qui sont radialement externes; des moyens (54, 60) permettant l'extraction de la matière hors de la région dotée de ceux des moyens d'admission annulaires qui sont radialement internes, des moyens (52) pour transférer la matière à partir d'une région sus-dite dont les moyens d'admission annulaires sont

disposés radialement vers l'extérieur de ceux d'une autre région, vers ladite autre région; des moyens (42, 44) pour fournir du fluide à chacun des moyens d'admission de fluide annulaires; et des moyens (32, 34) pour appliquer des composantes verticales et circonférentielles au flux de fluide à travers chacun des moyens d'admission afin de déplacer des lits respectifs de ladite matière se trouvant dans lesdites régions en bandes respectives le long de trajets annulaires concentriques respectifs, espacés radialement et axialement, dans lesdites régions lorsque ledit fluide traverse lesdits lits.

2. Appareil selon la revendication 1, dans lequel lesdits moyens d'admission annulaires desdites régions de traitement au nombre d'au moins deux sont espacés axialement, ceux desdits moyens d'admission annulaires axialement supérieurs (28) étant disposés radialement à l'extérieur desdits autres moyens d'admission annulaires (30).
3. Appareil selon la revendication 2 et comprenant plus de deux dites régions, dans lequel les moyens d'admission annulaires de chaque région autre que la région dotée des moyens d'admission axialement supérieurs sont disposés radialement vers l'intérieur des moyens d'admission se trouvant immédiatement au-dessus d'eux.
4. Procédé de traitement de matière dans au moins deux régions de traitement (12, 14) dont chacune est délimitée par une base (24, 26), dans lequel, dans chaque région, un lit de matière est déplacé en continu suivant une bande (29, 31) le long d'un trajet annulaire au-dessus de ses moyens d'admission de fluide (28, 30) en faisant passer du fluide fourni à la région (12, 14) par l'intermédiaire desdits moyens d'admission de fluide annulaires (28, 30) à travers le lit le long dudit trajet, les trajets annulaires des régions étant concentriques et espacés radialement, et dans lequel la matière à traiter est fournie à la région (12) ayant, parmi lesdits trajets, le trajet radialement externe, et extraite de la région (14) ayant, parmi lesdits trajets, le trajet radialement interne, la matière étant transférée à partir de la ou de chaque région dont le trajet annulaire est disposé radialement à l'extérieur de celui d'une autre région, vers ladite autre région.
5. Procédé selon la revendication 4, dans lequel les trajets annulaires des régions (12, 14) sont

espacés axialement, celui desdits trajets annulaires qui est axialement supérieur étant disposé radialement à l'extérieur de l'autre ou des autres trajet(s) annulaire(s).

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6. Procédé selon la revendication 5, dans lequel la matière est acheminée à travers plus de deux régions, chaque trajet annulaire autre que le trajet axialement supérieur étant disposé radialement vers l'intérieur du trajet annulaire immédiatement au-dessus de lui. 10
7. Procédé selon l'une quelconque des revendications 4 à 6, dans lequel ledit fluide qui est acheminé à travers lesdits lits se compose de matière gazeuse qui traite, ou réagit avec, la matière desdits lits. 15
8. Procédé selon la revendication 7, dans lequel la matière gazeuse comprend des gaz de combustion qui chauffent la matière desdits lits pendant leur passage à travers lesdits lits. 20
9. Procédé selon l'une quelconque des revendications 4 à 8, dans lequel ledit fluide qui est acheminé à travers lesdits lits se compose d'une matière liquide qui traite, se mélange avec, ou réagit avec la matière desdits lits pendant son passage à travers lesdits lits. 25
10. Procédé selon l'une quelconque des revendications 4 à 9, dans lequel ledit fluide qui est acheminé à travers lesdits lits se compose d'air. 30
11. Procédé selon l'une quelconque des revendications 4 à 10, dans lequel ladite matière qui est traitée dans lesdites régions de traitement se compose de matière particulaire. 35
12. Procédé selon l'une quelconque des revendications 4 à 11, dans lequel la matière qui est traitée dans lesdites régions de traitement se compose de matière liquide. 40
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